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(19)

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(54) HOT WORKING TOOL

(71) We, EUROTUNGSTENE, a French body corporate, of 54 Avenue Rhin & Danube, 38100 Grenoble, France, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to tools for use in the hot working of metals and alloys and by 'hot working tool' we mean a tool used in the hot working of metals in their *solid* state and specifically exclude tools used in the working of metals in their *molten* state such as die-casting dies, sprues, cores and hobs for the pressure casting of metals.

Hot working, of metals and alloys at between 700 and 1300°C, causes a difficult problem with regard to the behaviour of the tools in contact with the hot metal. This is the case in general with hot shaping tools, which are subject to high stresses and high thermal shocks, for example, the draw plates of wire-drawing dies and drills for the manufacture of seamless tubes.

The best tool steels used for these components undergo a deterioration of their mechanical characteristics at above 600°C and reach very low values above about 800°C. The use of super-alloys or hard-faced alloy coatings, for example, those based on cobalt, makes it possible to slightly raise the limit of use, but the characteristics of these materials drop significantly above 800°C.

Although so-called refractory steels have good mechanical characteristics when hot, their thermal conductivity is relatively poor and they have a high expansion coefficient so that they are relatively unsuitable for withstanding thermal shocks. This also applies in the case of tungsten carbide.

When high stresses at high temperatures and/or very significant thermal shocks are involved, the use of all these materials mentioned above makes it necessary to change the tools frequently. Finally certain special alloys that would be satisfactory as regards their behaviour when hot or unsuitable because the tools stick to the hot metal, thus causing surface defects.

The present invention is based on the discovery that certain tungsten based heavy alloys used in the past as gyroscope rotors or counterweights on account of their high density, as containers for radioactive material on account of their penetrating radiation absorption capacity, as grinding spindle adaptors or boring bars on account of their high modules of elasticity, and as surfacings on dies and other tools used in the hot working of molten metals (U.K. Patent No. 1,206,670) are useful in the construction of tools used in the hot working of metals at temperatures between 700 and 1300°C that are subject to high stresses and thermal shocks. Such alloys can ensure a long service life due to the use of materials having adequate high-temperature mechanical characteristics, a relatively low expansion coefficient, good thermal conductivity and no pronounced tendency to stick to the hot metal.

In accordance with the present invention, therefore, there is provided a hot working tool (as above defined) having as its working face an alloy consisting of, apart from impurities

tungsten	90—97 wt %
iron and/or nickel	2—10 wt %
chromium and/or molybdenum and/or cobalt	0— 8 wt % total.

Preferably the alloy consists (apart from impurities) entirely of tungsten, iron and nickel.

As an Example, the following alloys can be used:

% by weight	W	Ni	Fe
A	93	4.6	2.4
B	95	3.5	1.5
C	97	2	1

The breaking strength and elastic limits of these alloys are within the following ranges (in kg/mm^2):

	R	E
650°	55—75	32—45
800°	38—53	26—35

The expansion coefficient at these temperatures is about 5.10^{-6}/C degree, the thermal conductivity is approximately 0.25 cal/mm/C degree and the specific heat between 0.035 and 0.045 cal/g/C degree. All these properties give the tools made from such materials an excellent thermal shock resistance. Moreover, the stability of the metallurgical structure of these alloys, which undergoes no phase change during their temperature rise, is also a favourable factor. Finally, the formation, as from about 600°C, of a surface oxide (WO_3) permits an excellent lubrication of the metal to be shaped.

The tools according to the invention can be produced by conventional powder metallurgy methods, i.e. compression and fritting, and they can be machined without any special difficulty. They are suitable for the hot working of numerous metals and alloys and more particularly ordinary and special steels, and copper. It may be advantageous to produce composite tools in which only those portions in direct contact with the hot metal are made from the alloy according to the invention.

The invention is applied with particular advantage to tools used in the hot drawing of metals, such as draw plates, thrust bushes, needles and other tools used in the manufacture and shaping of seamless tubes such as drilling chucks or elbow forming pipes.

The advantages of the tools according to the invention will be shown by the following non-limitative example:

EXAMPLE

By powder metallurgy, a pear-shaped drilling chuck with an external diameter of 62 mm and a total length of 206.5 mm for use in the manufacture of seamless tubes made from bearing steel type 100C6 was produced. Drilling was carried out at about 1200°C.

The chuck was made from a heavy alloy with the following analysis (as % by weights)

W=95 Ni=3.5 Fe=1.5

This chuck made it possible to carry out 650 drilling operations. Its deformation was relatively limited and in fact below 0.5 mm. After surface machining, the chuck could be reused several times.

The previously used chucks made from 30NC 11 steel had to be dismantled after each drilling operation for cooling in a tank, which necessitated the permanent presence of a chuck fitter, or alternatively they had to be cooled internally and sprayed at the end of the drilling operation. They were able to perform a maximum of 50 drilling operations, representing about 20 changes per working station.

In addition, the chucks according to the invention made it possible to obtain a better surface state within the tubes and ensured more accurate dimensions.

WHAT WE CLAIM IS:—

1. A hot working tool as hereinbefore defined, wherein the working surface is formed of an alloy consisting of, apart from impurities:

tungsten	90—97 wt %
iron and/or nickel	2—10 wt %
chromium and/or molybdenum and/or cobalt	0— 8 wt % total.

2. A tool as claimed in claim 1, in which the alloy consists of apart from impurities tungsten, iron and nickel.

3. A tool as claimed in claim 1, in which the alloy is alloy A, B or C as hereinbefore described.

4. A tool as claimed in claim 1, 2 or 3, in the form of a draw plate, extrusion tool or tube-drilling chuck.

5. A method of hot working of metals subject to high stresses and thermal shocks, in which a tool as claimed in any one of claims 1 to 4 is used.

6. A method as claimed in claim 5 substantially as hereinbefore described in the Example.

7. Metal shaped by a method as claimed in claim 5 or 6.

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